Exploring the Moon in the 21st Century: Themes, Goals, Objectives, Investigations, and Priorities, 2008: Theme 3, Humans on the Moon. L. A. Taylor[1], G. J. Taylor[2], and C. R. Neal[3], lataylor@utk.edu, [1] Planetary Geosciences Institute, Dept. of Earth & Planetary Sciences, University of Tennessee, Knoxville, TN 37996; [2]HIGP, University of Hawaii, Honolulu, HI 96822; [3]Dept. of Civil. Engr. & Geological Sciences, University of Notre Dame, Notre Dame, IN 46556.

The Lunar Exploration Advisory Group (LEAG) has been charged by NASA with compiling input from the lunar community worldwide on the science and engineering considerations that should be addressed in plans for the exploration of the Moon and establishment of a human presence at a permanent lunar outpost. These ideas, principles, and concepts will be rendered into a formal NASA report on recommendations for the future of lunar exploration.

The three major themes that entail this noble endeavor are Theme 1: Pursue scientific activities to address fundamental questions about the solar system, the universe, and our place in them; Theme 2: Use of the Moon to prepare for future missions to Mars and other destinations; and Theme 3: Extend sustained human presence to the Moon to enable eventual settlement. Specifically, this paper addresses *Theme 3: All considerations associated with a human-presence on the Moon.* We have tentatively divided this major theme into 4 goals, each of which have been further divided into several objectives. These form the basis for our open forum at the 1st Lunar Science Conference at the new Lunar Science Institute at Ames Research Center.

GOAL 3A: IDENTIFY, DEVELOP, AND MATURE TECHNOLOGIES AND DEPLOY INITIAL INFRA-STRUCTURE CAPABILITIES.

Science, exploration, and commerce all require the development and emplacement of infrastructure to provide basic services (e.g., transportation, communications, navigation, power, habitation). It is essential that the technical, economic, and legal /regulatory/ policy considerations relevant to infrastructure development be addressed in an affordable and sustainable manner.

Objective 3A-1: Develop a capable space transportation system
Objective 3A-2: Develop the capability to use lunar resources
Objective 3A-3: Develop effective general infrastructure systems
Objective 3A-4: Develop robust surface transportation & navigation systems
Objective 3A-5: Establish adequate power systems on the Moon

GOAL 3B: REDUCE THE COST OF RESUPPLY AND DEPENDENCY ON EARTH.

Past and current human exploration activities in and beyond Earth orbit require a significant amounts of logistics to keep the crew alive and systems running. The logistics required include everything from food, water, and oxygen to sustain the crew and perform extra vehicular activities to replacement hardware and spares to fix hardware that has failed. The current lunar architecture transportation system is almost completely expendable except for reuse of solid rocket boosters and limited reuse of the Orion crew capsule. Lastly, all exploration and infrastructure capabilities must be built and delivered from Earth, so exploration and contingency recovery is completely dependent on if and when Earth delivery is possible.

Objective 3B-1: Construct facilities, manufacture hardware, materials, chemicals and other products on the moon using lunar resources.
Objective 3B-2: Provide food services on the Moon to support human habitation.

GOAL 3C: KEEP HUMANS HEALTHY AND SAFE OFF-PLANET.

This goal is supported by the need to comply with agency-level standards designed to assure the health and safety, and career longevity of the astronauts. From these standards flow a number of requirements that drive the design of systems for keeping the astronauts safe and healthy. They also drive procedures and processes for mission operations and space life sciences personnel to assure a healthy and fit astronaut corps. These activities require the close collaboration of: life sciences (space medicine, biomedical research for countermeasures, and environmental health/human factors and habitability); Engineering; Mission operations; Extravehicular activity (EVA) projects; and Flight crew.
Objective 3C-1: Incorporate results from basic biological research (Goal 1D) into the design of lunar settlements
Objective 3C-2: Characterize aspects of the lunar environment important for human health and safety.
Objective 3C-3: Provide safe and enduring habitation systems to protect individuals, equipment, and associated infrastructure.

Goal 3D: FACILITATE DEVELOPMENT OF SELF-SUSTAINING ECONOMIC ACTIVITY.

Sustainability and growth of lunar presence will require that resources come not only from government but also from the private sector. Public-private partnerships are needed to ensure that government activity facilitates to the greatest possible extent the development of commercial and other private-sector initiatives. Encouragement of entrepreneurship and private investment will play a key role in fueling innovation and economic expansion.

Objective 3D-1: Commercial development of lunar infrastructure.
Objective 3D-2: Media, entertainment, and recreational opportunities.
Objective 3D-3: Establish an export business from the Moon.
Objective 3D-4: Explore new methods of collaboration among industry, government, and academic entities.

In addition, there are four cross-cutting themes that link the themes and their goals together: 1) Learn to live and work successfully on another world; 2) Expand Earth's economic sphere to encompass the Moon, and pursue lunar activities with direct benefits to life on Earth; 3) Strengthen existing and create new global partnerships; and 4) Engage, inspire, and educate the public.